A C T A P A R A S I T O L O G I C A P O L O N I C A
VOL. IX WARSZAWA, 31.VIII.1961 FASC. 20

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Studies on *Protoptychostomum simplex* (André 1915), *Ciliata-Thigmotricha*

Badania nad *Protoptychostomum simplex* (André 1915), *Ciliata — Thigmotricha*

Protoptychostomum simplex (André 1915) belongs to the family *Hysterocinetidae* Diesing of the suborder *Thigmotricha* within the order *Holotricha*. *P. simplex* parasitizes in the end section of the intestine of *Eiseniella tetraedra* Sav.

It was first described by André 1915 under the name of *Anoplophrya simplex*; Heidenreich 1935 transferred it into the genus *Ptychostomum*, while Raabe 1945 singled it out to form a distinct genus — *Protoptychostomum* — on the grounds of the description given by Heidenreich. Meier 1954 gave her own description of this species, very inaccurate again. The present paper is aimed at filling this gap, and comparing *P. simplex* to other *Infusoria* of the family *Hysterocinetidae* (as were closely investigated by Raabe 1945 under the morphological aspect) and at carrying out studies on the process of morphogenesis of this parasite.

Material and methods

Ag impregnated *Infusoria* preparations after Klein and I. H. preparations following fixing in Schaudinn liquid were utilized in the present study. In addition, numerous phase contrast observations in vivo were carried out. The material was collected in the village Lubkowo on the Żarnowieckie Lake, Pomerania. The infusorians occurred in the end section of the intestine of *Eiseniella tatraedra* Sav., the invasion bearing a mass character on most occasions.

General description of infusorian

The body of *P. simplex* is — accordingly to the orientation given by Raabe 1945 — markedly laterally flattened the same as in all of the representatives of this family. Consequently, two surfaces ought to be distinguished: the left, and the right one, and the following margins: the ventral,

the dorsal, the anterior and the posterior one. This orientation was founded philogenetically by Raabe 1949, and has been confirmed by the author of the present paper. The present author thus rejects the Kozloff's suggestion to distinguish — in *Infusoria* of the family *Hysterocinetidae* — the superior and the inferior surfaces considering the flattening as dorsoventral.

There is a sucker placed along the anterior margin of the body on the left side. It looks like reversed V with the legs considerably apart, and the sucker's surface is smaller than in other representatives of the family *Hysterocinetidae*. The peristome is situated along the posterior margin, on the left side; its structure is the same as in *Hysterocineta*. Three parallel rows of basal cor-

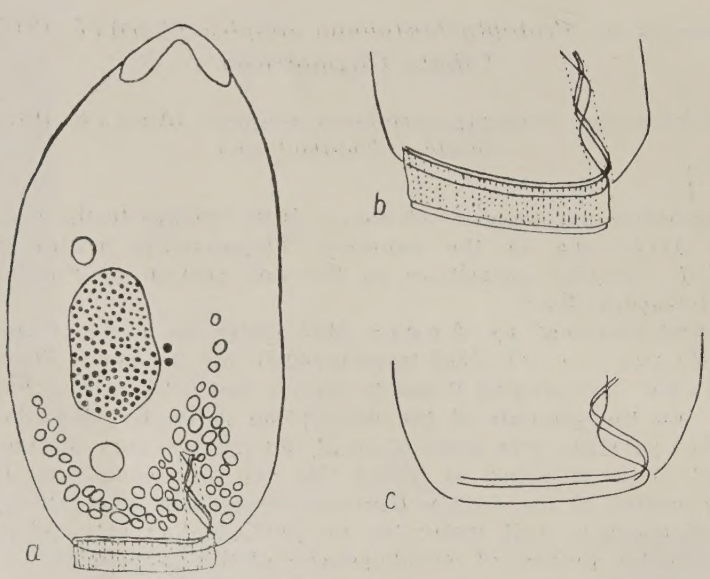

Fig. 1. a — *P. simplex*, I. H. preparation; b — *P. simplex* — buccal apparatus; c — *Hysterocineta eiseniae* Baer — buccal apparatus after Kozloff

puscles form the peristomal ciliature; these rows constitute the foundation of the pseudomembranella (Fig. 1a, b, and 2a, c). The distance between the first row (from the front) and the second one is very small, the peristomal field proper being situated between the second and the thrid one. The buccal cavity is situated on the dorsal end of the peristome (the term "buccal cavity" was first applied by Kozloff 1960, and is congruent with the protozoological standard terminology as published by Corliss 1959; in this particular case, it is synonymous with the term "cytopharynx"). The buccal cavity has the shape of a narrow funnel leading inside the body of the protozoon. Three adorally twisted spiral rows enter this funnel and descend as deep as approximately 1/4 or 1/3 of the infusorian body length if measured from the hind. In describing the buccal apparatus of *Hysterocineta eiseniae*, Kozloff 1960 writes about an inactive hyaline membrane situated inside the buccal cavity; this membrane is twisted and is connected with the penetrating adoral kineties. The present author observed this membrane in

vivo in studying the stomatogenesis in *Protoptychostomum*; it will be reported below.

However, Kozloff described not three but four kineties belonging to the peristomal ciliature of *H. eiseniae* and *Ptychostomum campeolomae*. This opinion seems erroneous considering the present author's own studies on *P. simplex* as well as the close examinations of the infraciliature in the family *Hysterocinetidae* carried out by Raabe 1947. The "i" kinety of

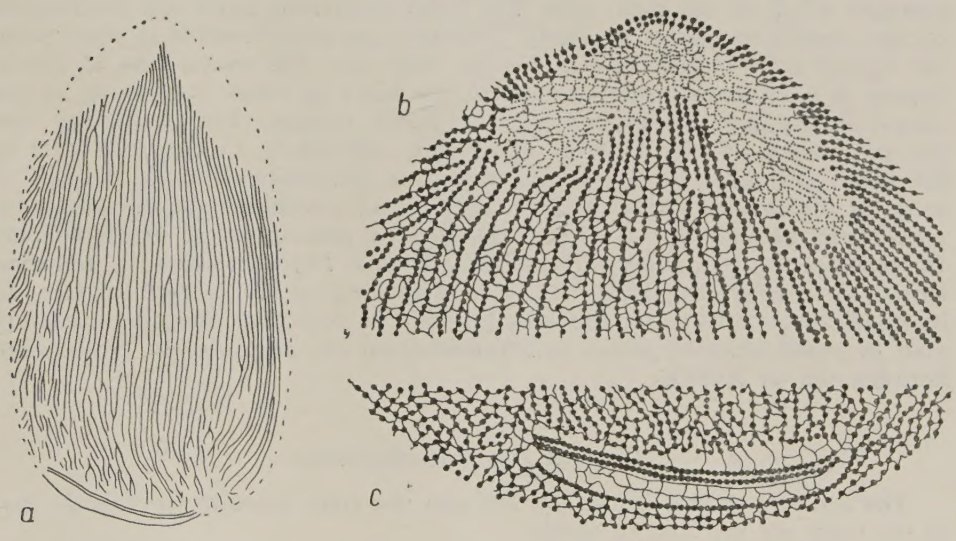

Fig. 2. *P. simplex*. a — Distribution of kineties after $AgNO_3$ preparation; b — Silver line system of the front part of body with thigmotactic area; c — of the hind part and peristome. $AgNO_3$ preparations

Kozloff (i.e. the first adoral one when looking from the front side, and which ends — according to Kozloff — at the buccal cavity entrance) and the third one as should begin at the same place seem to be in fact one and the same continuous kinety. The illusion of a gap may be caused by the kinety being twisted at the entrance into the buccal cavity. (Compare the diagram of the peristomal ciliature in *Hysterocineta eiseniae* after Kozloff to Fig. 1c).

The macronucleus is situated in the centre of the protozoan body and is spherical in shape or slightly elongated, while it is oviform in significantly elongated specimens. It is not uniform in structure. Distinct spherical granulae may be seen inside the Ma in vivo in phase contrast or inside the I. H. preparations. There are two micronuclei. They are situated near the macronucleus at the side of the dorsal margin. The zone of food vacuoles is situated in the rear part of the infusorian body; the zone is the same in shape as it is in *Hysterocineta paludinarum* Stein due to the food vacuoles

disposition along the two sides of the funnel-like buccal cavity and to their being able to form two horns directed forwards. There are two pulsatory vacuoles. They are disposed one behind the other near the ventral margin of the body.

Argyrophilous system

The kineties form parallel rows running from the periphery of the sucker towards the peristome. The distance between two neighbouring kineties averages 1.7 μ on the right side. The basal corpuscles rows are interrupted on the ventral margin of the body, and bifurcate which results in their number significantly increasing towards the rear part. The above kind of disturbances is considerably less obvious in the rows as reach the region of the buccal cavity and correspond to the dorsal margin. The continuity and the parallelism of the kineties disappears completely in the rear part of the body and three of the adoral rows run perpendicularly in respect to those of the somatic ciliature (Fig. 2a, c). These conditions remind analogous phenomena related by Raabe 1945 in his description of *Hysterocineta*. In contrast to the genera *Hysterocineta* and *Ptychostomum*, a manifest netting of distinct argyrophilous lines is lacking on the sucker surface. In its stead, an indistinct granular structure can be seen (Fig. 2b) (also visible in vivo, in phase contrast) which in *Ptychostomum* are also present, but are not impregnated by $AgNO_3$.

Division and stomatogenesis

The kineties as run across the left and the right sides of the middle part of the body are the first to divide.

The division furrow assumes the shape of a bow with its summit directed forward and its string cutting obliquely the kineties (Fig. 4). Consequently, the division is somewhat oblique and uneven, i.e. the rear specimen, the satellite, is insignificantly smaller than the front one, the primite. The ventral margin of the body forms a characteristic bulging over the dividing furrow thus adding to the general dissymetry of infusorian. The transversal division of the macronucleus is preceded by considerable gradual elongation of the same, which results in the macronucleus assuming a shape resembling that of a rod. The rear specimen forms its sucker anew, while the front one retains the existing sucker without any changements. The rear specimen's sucker is formed due to retiring (back of the division furrow) of the rows of the basal corpuscles disposed in the centre of the left body side (Fig. 5). A very dense netting of silver absorbing lines occurs on the free area thus formed; subsequently, these lines will desintegrate.

The maternal peristome vanishes completely much as observed by Wichterman 1942 in *Hysterocineta eiseniae* Baer. In both of the parting specimens, peristomal organization zone is formed. In the primite, this zone stretches along the ventral margin bending at almost 90° parallelly to the rear margin filling up the above mentioned bulging of the ventral margin. In the satellite, the organization zone of the new peristome covers

the surface of the old peristome and a stripe of the membrane situated exactly over the old buccal cavity as well. The peristomal organization zone assumes the same position as that in the primite owing to the sateliite becoming elongated and because of the bulging increasing towards the rear margin of the latter. It seems to be shifted onto the ventral margin; in fact, however, it is subject to an insignificant displacement only. The peristomal organization zones are slightly depressed in relation to the pellicle surface

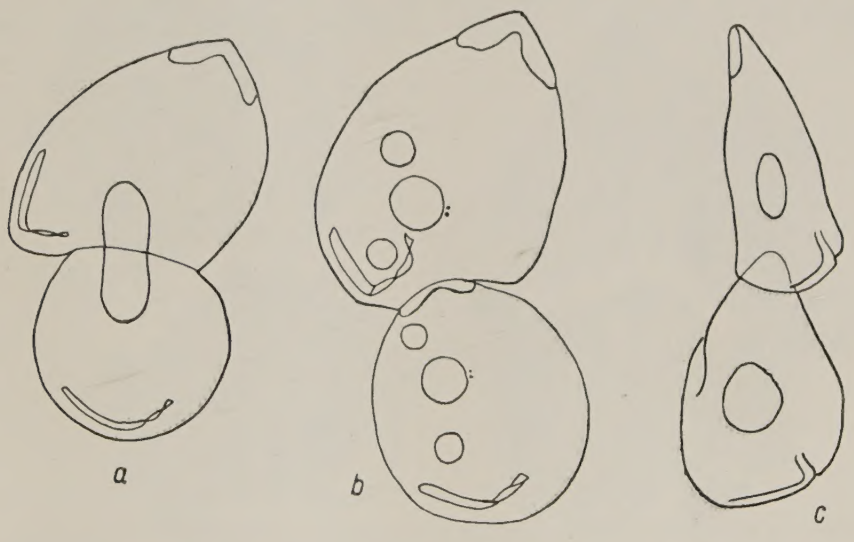

Fig. 3a, b. — Fission stages of *P. simplex*, after phase contrast infravital microphotographs; peristomal organization zone, formation of the new buccal cavities, and their spiral torsions are marked; c— Conjugation of *P. simplex;* after I. H.

of the infusorian thus assuming the shape of grooves. The anterior peristomal area embraces a part of the somatic ciliature of the primite. The short and interrupted kineties occurring here are subject to disintegration. Also a part of the basal corpuscles seems to disappear. The posterior peristomal area behaves much the same. A long funnel-like deepening forms at the cytostomal end of the peristomal areas (or grooves); ectoplasm seems to sink into this deepening forming the buccal cavity. On the surface corresponding to the buccal cavity, the present writer observed (in vivo) a spirally twisted band of a part of the peristomal area penetrating inside the cytoplasm (Fig. 3). Most probably, this is the hyaline membrane of endoplasmatic origin bordering the buccal cavity as reported by Kozloff 1960. Its twist corresponds exactly to that of the oral kineties as will form subsequently. This membrane also stretches under the peristomal area proper making it very distinct and visible in observations in vivo in phase contrast. The formation discussed would correspond to the skeletal elements occurring in the *Peritricha*'s infundibulum; these elements form the foundations of the adoral membranellae

described by Peshkowsky 1923 in her study on *Trichodinopsis paradoxa*. Further investigations are necessary to obtain an exact knowledge of the structure, nature and situation of the element as borders — in *Protoptychostomum* — the buccal cavity under the form of a twisted band. Three adoral rows of basal corpuscles appear at the last stage of division when two macronuclei are already formed and the primite is connected with the satellite

Fig. 4. Fission of *P. simplex;* distribution of kineties is marked. preparation

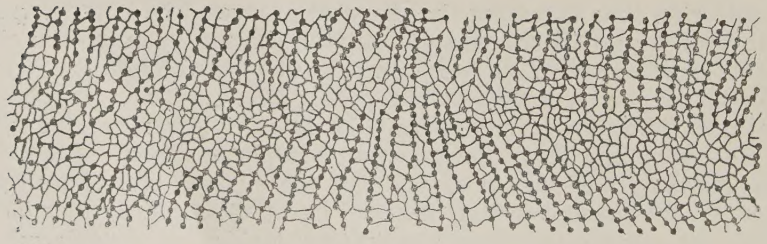

Fig. 5. Formation of the sucker in *P. simplex* opisthor

by a narrow stripe of cytoplasm only. These rows appear on the already existing section of the buccal cavity and on the adoral one simultaneously. They are already twisted at the moment of their formation. This is shown by the comparison of the I. H. staining results with the smears of infusorians impregnated with silver after Klein.

Morphogenetic postdivision phenomena

As a result of the division, two specimens are formed which markediy differ in shape at the beginning. The primite is relatively wider with a characteristic cut in the rear margin of the body, the result of the above described course of the division furrow. Initially, the peristome is situated obviously on the ventral margin. The satellite is narrower and elongated; the dorsal end of the peristome is more or less situated at the posterior pole of the body. The differences between the two "division specimens" gradually disappear as their development progresses. Initially, the growth of the primite

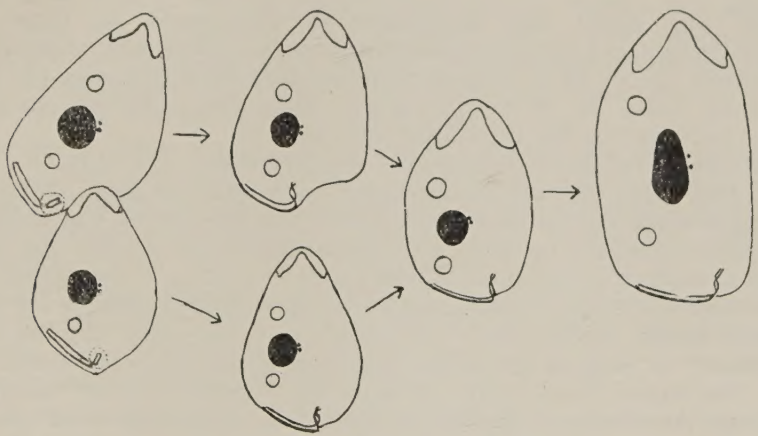

Fig. 6. Scheme illustrating the postdivisional morphogenetic changes in *P. simplex*

is not a simple process of growing along a longitudinal and a transversal axis; it is, on the contrary, a complex phenomenon. An elongation at the summit point of the cut of the posterior margin of the body seems to occur simultaneously with shrinkage of length (drawing up) in the region where the cytostome is situated. This is related to the further stretching of the ventral margin of the body, and to the gradual turning of the peristome. As a result the peristome is shifted onto the body's posterior margin which becomes completely even. An insignificant turnover of the peristome occurs also in the satellite; as a result of this, the posterior margin of the peristome (Fig. 6), previously bulging backwards, now becomes even so as to mark the rear cut of the body. Consequently, the shifting of the peristome onto the posterior margin of the body is related to the growth process and to the stretching out of the ventral margin of the protozoan body, both in the primite and in the satellite. The very peculiar structure of the buccal apparatus itself could, in part, account for the growth phenomena discussed. The drawing in and the shrinking of the cytostomal region in the primite might result from the activity of the buccal cavity giving rise to a current directed inside the cytoplasm. However, it should be born in mind that this current had to exist at the moment when the buccal cavity was being formed for otherwise the formation of the latter could not be imagined. The fact of the very dense

arrangement of the basal corpuscles in the kineties forming the foundations of the peristomal pseudomembranellae seems important in this respect; for the dense arrangement of the basal corpuscles may constitute important pellicle foundation elements which probably are reinforced by the hyaline membrane mentioned above. One may fancy these elements as sufficiently stiff rods situated on the posterior margin of the protozoan's body; this margin will easily form a backwards bulging following the disappearance of the elements mentioned. Besides, the drawing (pulling) in as occurs in the cytostomal region may also cause the peristome to turn up and the ventral margin to stretch out. It should be born in mind that the phenomena discussed are much more complicated even if the above suppositions should prove true in part.

Beyond any doubt, the morphogenetic phenomena as occur within the genus *Protoptychostomum* develop in a very similar way with the genus *Hysterocineta* Diesing. This is made evident by the studies of Raabe 1949 and by those of Wichterman 1942, and especially so by their drawings representing the division stages.

As to other *Infusoria* the genus *Ancistrumina* Cheissin 1931 — Raabe 1959 from the family *Hemispeiridae* seems the most similar to the family *Hysterocinetidae* as structure is concerned. The lateral flattening occurs in this genus similarly as it does in *Hysterocinetidae*. Almost the whole of the ventral margin is occupied by the peristomal area. Two adoral kineties form the basis of the pseudomembranella which is shifted towards the backside of a small buccal cavity. They are parallel to the body kineties and are approximately as long as the latter. Apparently, they are specialized somatic kineties. The hypothetical initial form of the *Hysterocinetidae* family might differ from *Ancistrumina* in the number and arrangement of the adoral kineties. Three of them, two on the left side and one on the right (dorsal) side, would limit the peristomal groove situated along the ventral margin. The buccal cavity would be at its end. The general body shape would be similar in both this hypothetical infusorian and in *Ancistrumina*. In both of these cases, the adoral kineties would also be similar to the kineties of the somatic ciliature as regards their direction and length.

The evolution of such a hypothetical infusorian would consist in an increased growth towards the ventral margin which would cause the retrogradation of the peristomal ciliature (Raabe 1953). On the additional pellicle surface thus obtained, the characteristic system of short, ramificating and interrupted kineties would form. The arrangement of the adoral kineties would change from parallel to transversally oblique in respect to the elongated kineties of the somatic ciliature. Then, the buccal cavity, typical of *Hysterocinetidae*, should be formed. The formation of that latter organellum is related to the further turning of the peristome (as was shown above) which definitely settles along the rear edge of the body, and to the ventral edge stretching further out. At this point, attention should be payed to the fact of the adoral kineties (the pseudomembranellae) in the dividing specimens being not much shorter than the kineties of the somatic ciliature, and to this ratio changing only later on when the kineties of the somatic ciliature will gradually elongate together with the lengthwise growth of the body, while the length of the adoral kineties remains unchanged. The com-

plicated stomatogenesis would be a secondary phenomenon. A transversal division of the adoral kineties together with the division of the kineties of the somatic ciliature may be supposed to occur in the hypothetical ancestral form described above.

Concerning the process of stomatogenesis

The process of stomatogenesis in *Infusoria* goes on in various ways.

1. In *Peritricha*, new adoral kineties come into being as a result of the longitudinal division of the kineties of the old adoral spiral of the dividing specimen. One of them is the haplokinety, and the other — the polykinety. Outside each row of the old spiral, a new one is formed that encloses the former, and has a different structure. As a result, two double spirals are formed, one enclosing the other. As the process continues, the spirals untwist and twist once again. This course of stomatogenesis, described by Chatton et Villeneuve 1937 is typical of *Peritricha* only.

2. In many other species, the formation of both the new cytostome and the new buccal ciliature is related to the stomatogenous kinety running in the direct proximity of the mouth apparatus and continuing in the body of the rear specimen (*Tetrahymena* — Chatton et Lwoff 1931, *Pseudomicrothorax* — Corliss 1958, *Apostomea* — Chatton et Lwoff 1935).

In her monography on *Heterotricha*, Villeneuve-Brachon 1950 showed the occurrence of one stomatogeneous kinety in *Chattonidium* much as in the cases mentioned above. Yet, there are several stomatogeneous kineties in most of *Heterotricha*.

All of these phenomena can be perfectly well compared to those reported in the descriptions of *Tetrahymena* and *Pseudomicrothorax*. The difference consists solely in the organization-zone of the latter two being small, and in the four small ciliary areas differentiating out of it to form the basis of the tetrahymenium.

In *Protoptychostomum*, the pattern of stomatogenesis differs from that described above. As it already was stated, this process seems to be secondary in its character due to the secondary shift of the peristome into the rear margin of the body. The most important features distinguishing the course of this process in *Protoptychostomum* from that in *Hymenostomata* are the following:

1. Absence of kineties which could be regarded as stomatogeneous ones. Absence of the anarchic areas of basal corpuscles, typical of *Hymenostomata*, constituting their irregular agglomerations. In *Protoptychostomum*, the pseudomembranellae are formed of basal corpuscles, loosely scattered (not forming any agglomerations) on the surface of the organization-zone (the peristomal groove, and inside the buccal cavity).

2. In the primite, the organization-zone of the new persitome forms entirely on the surface occupied by the somatic ciliature, and it covers a part of this surface in the satellite too. In *Hymenostomata*, e.g. in *Tetrahymena*, *Pseudomicrothorax* etc. the anarchic areas are formed between the stomatogeneous kinety and the next one, not interferring into their arrangement. Howe-

ver, it results from the data given above that the ciliature of the ventral margin bears a secondary character and is irregular.

The thesis of Kozloff according to which the buccal apparatus of *Hysterocinetidae* would be formed as a result of evolution of that of *Hymenostomata* (Kozloff 1960) does not seem doubtless in view of the observations related above. Taking into account the different opinions of Chatton et Lwoff 1938, and of Raabe 1959 on the stomatogenesis process in the family *Hemispeiridae* (*Thigmotricha*), the solution of this problem would be decisive as regards the final definition of the relationship between *Hemispeiridae* and *Hysterocinetidae*. In describing the process of stomatogenesis in *Proboverria loripedis*, Chatton et Lwoff 1938 confirmed ciliary areas with anarchic character in this infusorian; they regarded these areas as equivalent to the particular parts of the buccal ciliature, i.e. to the tetrahymenium in *Tetrahymena* (*Glaucoma*). Raabe opposed these conclusions drawn by Chatton et Lwoff even if he did not call in question the findings of the two authors.

Still, the observation of the divisions reveals a distinct physiological interdependance between the peristomal region of the anterior and the posterior specimens during division. The division furrow induces, beyond any doubt, identical changes in the parts of the body which correspond to each other topographically. The only difference consists in the reorganization-zone of the posterior specimen covering not only the somatic ciliature but — amongst other — the former peristome.

A similar interdependance between the formation of the new peristome and the changes simultaneously occurring in the old one may be observed in several protozoans with buccal ciliature consisting of pseudomembranellae or membranellae. These membranellae and the old cytostome are subject to disintegration in *Tetrahymena*, in *Pseudomicrothorax* from *Holotricha*, and in many *Heterotricha*. Next, they will range anew of the basal corpuscles which are very dense here, and will form due to proliferation of one or several stomatogeneous kineties. Also the cytostome is formed anew. At the same time, identical processes occur in the anterior and posterior specimens as are being formed.

The same interdependence (and in the same degree) is characteristic of other complex organellae produced by the ciliary system such as, for instance, the cirri are in *Hypotricha*. Here, organization-zones of cirri appear, during the division process, in the anterior as well as in the posterior specimen. Each of the new cirri will then assume its proper position while the old cirri will be subject to resorption.

Experimental studies on this ability in various species and after various methods would doubtlessly help to reveal the character (mechanism) of the interdependence between the new membranellae or cirri simultaneous formation in both of the forming infusorians. The present writer has defined that a physiological interdependence for the specimen dividing presents a functional unity, and both of its parts, the two presumptive specimens, are subject to several identical morphogenetic processes induced by the same organizational factors.

Conjugation

When starting conjugation, one of the conjugants attaches itself with its sucker to the end of the ventral margin of the other one, directly over the peristome; in smears, this could be mistaken for division (Fig. 2c). Conjugation in *Ptychostomum*, as described by Heidenreich 1936, occurs in a similar way, one of the conjugants attaching itself with its sucker to the edge of the body of the other one. During division, the area situated ventro-frontally to the peristome is subject to maximum stretch. This is the point where the protozoan reaches its maximum width. The pellicle may possibly be most tensile here which fact may facilitate mechanically the sucking in of the other conjugant. These conditions are much the same as those characteristic of the genus *Ancistrum* with one of the conjugating infusorians clinging with the anterior part of its left side to the ventral margin (over the peristome) of the other one (Kidder 1933). The process of conjugation continues then according to the generally known pattern.

Phylogenetic relations of *Protoptychostomum*

In his study on *Elliptothigma limnodrili* Meier, Puytorac 1957 suggested the hypothesis of common origin of the families *Hysterocinetidae* (*Thigmotricha*) and *Hoplitophryidae* (*Astomata*). In the species examined, he showed the occurrence of catenular division very typical of the genus *Radiophrya*. Besides, he observed on the ventral margin indistinct divergencies in the arrangement of the kineties (système secans after the terminology of Chatton et Lwoff), and compared them to analogous phenomena in *Radiophrya*. Katashima 1951 observed also the catenular division in *Ptychostomum filiferum* from the intestine of *Limnodrilus gotoi* Hatai in Japan.

Some of the characters resembling those of *Radiophrya* (although differing from the characters of *Elliptothigma limnodrili*) are still more markedly expressed in *Protoptychostomum* than in other representatives of the family *Hysterocinetidae* which fact corroborates the hypothesis of Puytorac. These characters are: the shape and the small surface of the sucker (which resembles very much the anterior ciliaeless area in *Radiophrya*), and the very marked disturbances in the longitudinal arrangement of the kineties on the ventral edge, and in the much less significant ones on the dorsal edge. The latter character occurs distinctly also in *Hysterocineta*, less distinctly in *Ptychostomum* and is almost completely absent in *Elliptothigma* with its sucker highly advanced in development.

Radiophrya olivieri Puytorac 1954 is more distinctly related to *Hysterocinetidae* than the remaining *Radiophrya* species:

(1) The anterior ciliaeless area in the form of reversed V covers a relatively large surface and may be easily compared to the sucker of *Protoptychostomum*.

(2) The body of *Radiophrya olivieri* is asymmetric. This is related to the division furrows running somewhat obliquely as it may be seen in the photographs published by Puytorac 1954. The above character is considerably less markedly expressed in *R. olivieri* than in *Hysterocinetidae* but it still can be easily discerned (Fig. 7).

When considering the relationship between the genera discussed, it should be weighed which of the characters mentioned are indicative of the common origin of the genera, and which on the contrary are mere convergences which came into being as a result of adaptation to parasitism. The body asymmetry, the similarity in the arrangement of the kineties as well as the shape of the

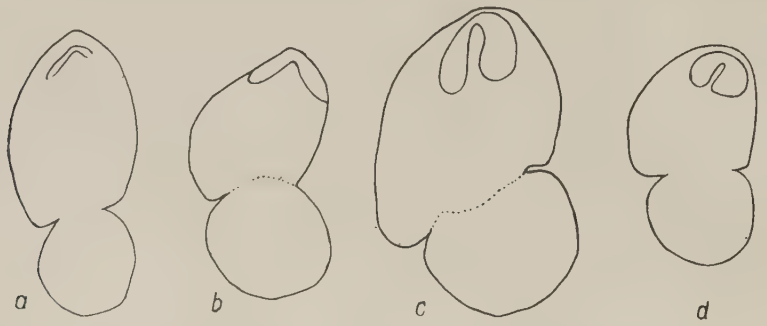

Fig. 7. Schemes of fission of: a — *Radiophrya olivieri* (after Puytorac); b — *Protoptychostomum simplex* (orig.); c — *Hysterocineta paludinarum* (after Raabe); d — *Ptychostomum saenuridis* (after Raabe)

sucker seem to belong to the first category, while the cyto-skeleton and the catenular division — to the second one. The catenular division could develop independently in *Radiophrya* and *Elliptothigma;* yet, it is indicative of the predispositions and properties being similar in those genera as was observed by Puytorac 1954. Related to the catenular division is the elongation of the primite, that of its nucleus, and the increase of the number of the contractile vacuoles which make the forms discussed very markedly similar to each other.

The above consideration enable us to presume the common origin of the particular genera of the families of *Hysterocinetidae* on the one hand, and of *Radiophrya* from *Astomata,* on the other. This is illustrated by the diagram (Fig. 8).

The hypothetical common ancestor would have the following characters: (1) A marked lateral flattenning of the body, (2) the peristome situated on the posterior body margin, the same as in *Protoptychostomum* and in *Hysterocineta,* (3) a small ciliaeless area (in the shape of reversed V) situated on the thigmotactic surface on the left side at the front of the body, (4) less or more distinct divergencies and bifurcations in the kineties situated on the ventral margin of the body, the kineties here being somewhat divergent.

From the above hypothetical form, the development would go in several directions:

In *Radiophrya,* the V-shaped basis of the cyto-skeleton was formed in the anterior ciliaeless area with numerous rays radiating from that foundation. In *Hysterocinetidae* this very area developed into the sucker. Two types of sucker may be distinguished according to Raabe 1945. The first of them, the less advanced in development, occurs in *Hysterocineta* and in *Protoptychostomum* while other one occurs in *Elliptothigma* and in *Ptychostomum.*

The latter is notable for its sucker arms cut off the rows contained between them from the ciliature of the whole body (partly in *Elliptothigma*, and completely in *Ptychostomum*). Further, complex systems of reinforcing fibrillae occur here to form the cyto-skeleton of the sucker (P u y t o r a c 1951).

An essential point in understanding phylogeny of the genus *Radiophrya* is the catenular division which occurs in *Elliptothigma* too. This phenomenon seems to result from transition to the advanced intestinal endoparasitism. Under these conditions, the whole surface of the infusorian's organism will

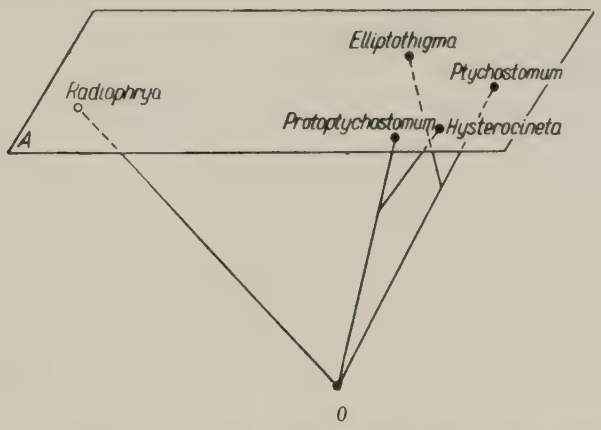

Fig. 8. Spatial diagram illustrating hypothetical relations between the genus *Protoptychostomum*, other genera of *Hysterocinetidae*, and the genus *Radiophrya* (*Astomata*)

Particular points on the plane A represent the genera considered; distances between their disposition on the plane depict the existing systematic relations, while the lines connecting them with the point 0 indicate the hypothetical paths along which they evolved from te common ancestor

absorb the nutritive substances dissolved in the contents of the host's intestine. These may be immediately included into the metabolic cycle of the parasite being not subject to the process of digestion. This induces a considerable acceleration of growth processes in the protozoans causing elongation of the whole body, and increase the rate of divisions succeeding very quickly one after another. The formation of new division furrows will outstrip the morphogenetic processes in the satellites inducing their tearing off.

To the present writer's opinion, catenulation is the cause which induces astomatism in *Radicphrya*. It is verisimilar in view of the backwards position of the peristome, and the complicated changes it undergoes whilst dividing in *Hysterocinetidae* (and consequently, the possible delay in stomatogenesis), and if the same properties be assumed in the form from which *Radiophrya* originated.

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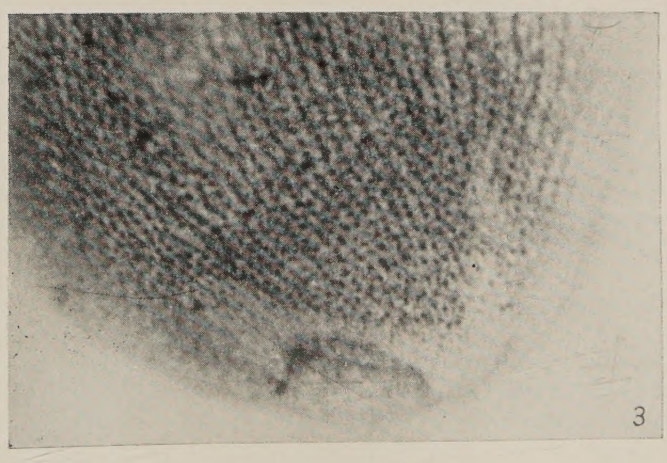
STRESZCZENIE

Autor omawia morfologię i morfogenezę orzęska *Protoptychostomum simplex* (André) z rodziny *Hysterocinetidae* (*Thigmotricha*) w oparciu o badanie zmian w układzie rzęskowym. Przyssawka powstaje w satelicie tak jak to opisywał Raabe 1949 dla *Hysterocineta* i *Ptychostomum*, podczas gdy prymit zachowuje swoją bez zmian. Interesujące jest, że w okresie podziału stary peristom zanika, a zarówno w prymicie jak też w satelicie tworzy się peristom na nowo.

Autor zwraca uwagę na różnice kształtu prymita i satelita zaraz po podziale i na popodziałowe procesy morfogenetyczne, które polegają na zmianach kształtu tylnej części ciała orzęska i zmianach położenia peristomu. W końcowej części pracy autor zwraca uwagę na szereg wspólnych cech *Protoptychostomum* i *Radiophrya* (*Astomata*) i wysuwa szereg nowych argumentów przemawiających za słusznością hipotezy Puytorac'a 1957 o pokrewieństwie rodziny *Hysterocinetidae* i rodzaju *Radiophrya*.

EXPLANATION OF PLATE I

Phot. 1. Conjugation of *Protoptychostomum simplex*; $AgNO_3$ prep.
Phot. 2. Organisation zone of the new peristome in primite of *P. simplex*.
Phot. 3. The same in the opisthor of *P. simplex*.



A. Kaczanowski auctor phot.